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(54) Pyrolytic self-cleaning ovens

(57) A pyrolytic self-cleaning oven has a cavity 2 heated by a grill element 4 during a self-cleaning pyrolytic operation, the fumes emitted passing through a porous plug bearing an oxidation catalyst 11 to remove smoke before the gases are vented at outlet 9. The cycling of the element 4 is controlled by an electronic controller 13 which receives a signal from a temperature sensor 15 on the catalytic plug. Thus, when the oven temperature initially rises and volatile substances are vaporised, resulting in an exothermic reaction at the catalyst, the element 4 is switched off. Only when a substantial amount of the volatile soil has been evaporated will the temperature at the oxidation catalyst fall causing the control means 13 to switch the element 4 back on. In this way, the self-cleaning operation is controlled by the temperature of the oxidation catalyst, and the cleaning operation is terminated with reference to either a fixed temperature in the oven having been reached or a fixed temperature differential between the catalyst temperature and the oven temperature having been achieved.

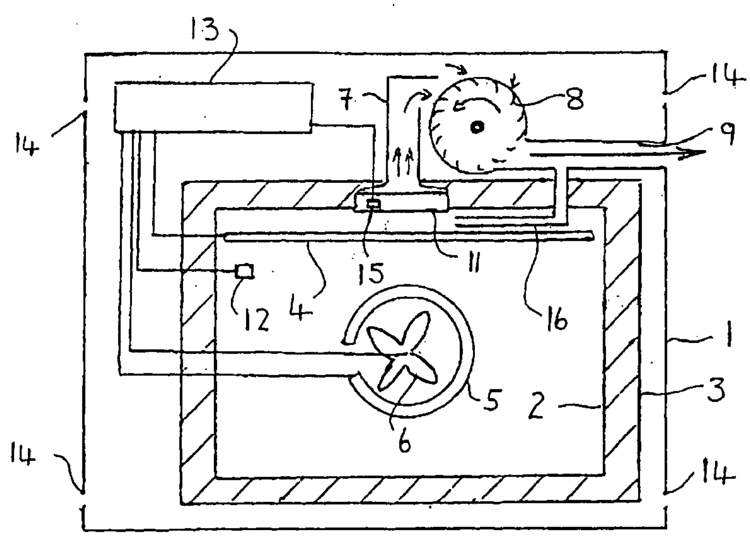

FIGURE 1

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Description

This invention relates to pyrolytic self-cleaning ovens.

Such ovens are able to undergo a cleaning operation whereby the oven temperature is maintained at a high value, typically above 400°C, for an extended period of time, typically in excess of an hour. The material deposited on the surface is inside the oven is decomposed through heating, and carbon dioxide and moisture are vented to the outside. An oxidising catalyst may be provided in the outlet for the oven in order to permit oxidation of vaporised materials to be completed.

Typically, during conventional pyrolytic self-cleaning, the oven was heated with a fixed time/temperature profile, to a temperature in the range 470 to 500°C and held at this temperature for a period of some 60 to 80 minutes. The exact temperature would have been chosen so that the coolest internal surfaces requiring to the cleaned reached the temperature of at least 420°C but with the hottest areas staying within the capabilities of the enamel. The time period would have been the shortest to give acceptable cleaning with average amounts of deposit. There were two disadvantages with this usual arrangement. The duration and therefore, energy usage, would usually not have been optimised to suit the amount of deposit. In order to achieve acceptable cleaning every time, the oven might well have been set so that, for light deposits, it was held at 500°C for more than 1 hour longer than necessary. Typical ovens in the 50 to 60 litre capacity range require some 2 to 2.5kW to maintain this temperature.

The second disadvantage was that the catalytic convertor could overload with heavy amounts of particularly volatile deposit. As the oven heated through the 300 to 350°C range, excessive flow of effluent through the oxidation catalyst could have resulted due to insufficient dwell in contact with the catalyst, insufficient preheating of the catalyst or insufficient oxygen available, or a combination of all three. This overload resulted in the ejection of unpleasant eye-watering gases, smoke and carbon monoxide from the oven.

With energy conservation in mind, ways have been proposed (US-A-4 954 694, US-A-4 481 404) of terminating the self-cleaning operation when the deposited materials have all been vaporised or burnt off, rather than maintaining the elevated temperature for a fixed period of time, which could mean wasted energy in the case of only mild deposits. In these proposals, a gas sensor has been provided in the outlet from the oven to sense one or more characteristics of the effluent emerging from the oven. The gas sensor has also been used to de-energise temporarily the oven heating elements in the event of overload of the catalyst (US-A- 4 481 404). There is however a compromise between the best positions for the gas sensor to sense overload and to sense the end-point of the self-cleaning operation.

The invention provides a pyrolytic self-cleaning oven, comprising a heating element for the oven, an oxidation catalyst in an outlet from the oven, a temperature sensor arranged to sense the temperature in the vicinity of the catalyst, and means for controlling the operation of the heating element during self-cleaning in dependence on the temperature of the sensor.

By using the temperature of the catalyst as a control signal, it is possible both to reduce energy wastage as well as to reduce catalyst overload in a less expensive manner while avoiding the positioning problems inherent in a gas sensor.

A pyrolytic self-cleaning oven constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of the oven; and

Figure 2 shows temperature/time curves relating to the use of the oven shown in Figure 1.

Referring to Figure 1, the oven is contained in an outer cabinet 1, the oven cavity consisting of a steel box 2 coated on the inside with vitreous (porcelain) enamel and covered with insulation 3 on the outside. The enamel and insulation are chosen to accept internal temperatures up to 500°C. A grill (broil) element 4 is provided towards the top of the oven cavity 1. A circular heating element 5 surrounds a fan 6 positioned at the rear of the oven cavity to provide for circulation of heated air around the oven for baking.

The oven cavity opens at the top into a vent 7 through which exhaust fumes from the oven are sucked by tangential fan 8, before being vented out of outlet passage 9. Tangential fan 8 (or a centrifugal fan could be used) however greatly dilutes such oven fumes with fresh air drawn in through openings 14 in the outer cabinet which passes over electronic controller 13.

Fitting closely in the outlet vent 7 is a porous plug 11 of ceramic material coated with a catalytic precious metal layer forming an oxidation catalyst. All gases pass through the parallel vertical tunnels of its honeycomb structure. Wire mesh could be used in place of ceramic material.

The oven cavity is provided with a temperature sensor 12 which is connected to the electronic controller 13, to which the terminals of the motor of the fan 6 are also connected.

The oven is also provided with means to enable it to be locked for safety purposes during self-cleaning.

The porous plug 11 carrying the oxidation catalyst is provided with a temperature sensor 15 which is linked to the electronic controller 13. In addition, an inlet vent 16 is provided which allows preheated air into the oven at a position close to the outlet vent 7. Advantage is taken of the slightly-higher-than-atmospheric pressure in the outlet passage 9 when the fan 8 is running.

In operation, starting from room temperature or, op-

tionally, to save energy, following on from a baking operation, the oven is heated using the grill element 4 taking temperature feedback from the temperature sensor 15 in the porous plug, to reach and maintain a temperature of the porous plug in the range 450 to 600°C, the exact temperature depending mainly on the catalyst type. The temperature should be above the activation temperature of the catalyst and high enough to allow significant smoke odours and carbon monoxide elimination.

With oven soil present, the exothermic reaction of the oxidation of effluent in, and the self-heating of, the porous plug 11 might result in this point first being reached with an oven centre temperature in the range 300 to 350°C. At such temperatures, the first volatile effluent products tend to be presented as smoke to the porous plug at a high rate. The heating element 4 is switched off, for the first time, at this point, limiting the rate at which effluent is produced.

The cycle proceeds with the element 4 being switched on and off to keep the porous plug, which is acting as a smoke-eliminator, at the chosen temperature in the range 450 to 600°C. As the soil becomes used up, and the effluent rate falls, the self-heating of the porous plug also falls and more heat is then required from the element 4 to maintain its temperature. The oven temperature therefore rises, rising in a manner controlled largely by the quantity of soil remaining and its volatility, thus preventing smoke-eliminator overload.

Towards the end of the cleaning process, the self-heating drops to a negligible amount and this allows the oven centre temperature to approach, or depending on the ventilation arrangement, even slightly to exceed, the controlled temperature at the plug. At this point, the electronic controller 13 can identify an end-point datum. This is done when the temperature sensor 12 in the oven reaches a threshold temperature (say, 500°C). An alternative way of identifying the datum would be by using a signal which arises when the difference between the temperature of the oven temperature sensor 12 and the porous plug temperature sensor 15 falls below a predetermined amount.

Oven temperature is also monitored using temperature sensor 12, not only in order to detect the end-point, but also to accommodate failure/degradation of the catalyst or spontaneous combustion of soil in the oven cavity.

It should be added that with very volatile soil it might be possible for the catalyst to heat to 700°C or more, with the oven at only 320°C. When this happens, it is important to turn the elements off to prevent overload caused by driving the oven soil off too fast. The catalyst will work typically from 350°C to 400°C up, becoming more effective at higher temperatures. Temperatures over 700°C however can cause the catalyst to age and become less effective.

Referring to Figure 2, curves B to D show respective oven temperatures for the conditions of light soil/no soil, medium soil and heavy soil. Curve A shows the corresponding temperature at the porous plug temperature sensor 15. The end-point datums are shown as lines b to d corresponding to the respective curves B to D. The curves are smoothed to illustrate the control principle. In practice, short-term fluctuations of 100°C might occur, depending on the control response and soil amount.

Having identified the datum, the grill element 4 may be switched off to combine adequate cleaning with least energy use. However, some areas of the oven interior, particularly the lower part just inside the door opening, or the inner window of the door, might not have reached the required 420°C for self-cleaning and may be left with a hard black layer of carbon-rich soil, which would be almost impossible to remove manually after the oven had cooled.

To prevent this, heating can be continued for a further 20 to 30 minutes fixed period, keeping the oven centre temperature at 500°C, via the oven temperature sensor 12, in order to allow the cooler surfaces to self-clean. The elements are then switched off and the oven allowed to cool. As an alternative, the fan 6 can be switched on, possibly in conjunction with element 5, for a fixed period of some 10 to 15 minutes in order to equalise the temperatures over the oven interior. The fan and elements can then be switched off to allow the oven to cool. As another alternative, auxiliary elements may be provided at the base or door aperture of the oven to be switched on for a fixed period of 10 to 15 minutes before all are switched off and the oven is allowed to cool.

Both temperature sensors 12 and 15 are conveniently platinum resistance thermometers, which could be printed onto a suitable substrate, but other types of temperature sensor involving a thermocouple could be used if desired.

Although the oven has been shown as having a single grill element 4, additional grill elements could be provided, and these could be used together to heat the oven for self-cleaning. The invention is, however, applicable to gas ovens, in which case a gas burner would be ignited in place of the element 4 being energised.

It will be noted that the porous plug 11 has been placed close to the grill element 4, in order to give it the best chance of reaching its activation temperature of at least 300°C before any smoke is released. If the grill element 4 was not positioned close to the porous plug 11, the porous plug 11 may be provided with its own heater to raise its temperature as soon as the self-cleaning oven operation is commenced. Such a heater could be provided even with the arrangement shown in the drawing.

While the temperature sensor 15 is shown as being in contact with the porous plug, the sensor 15 could be positioned slightly above the plug.

A typical plug could consist of a cylinder, approximately 1½" diameter x ½" deep, the surface of which has of the order of 100 through-holes, of approximately 2mm diameter. It could consist of a ceramic material with an

aluminium oxide coating. At the surface, there may be platinum, or a mixture of platinum and palladium.

Claims

1. A pyrolytic self-cleaning oven, comprising a heating element for the oven, an oxidation catalyst in an outlet from the oven, a temperature sensor arranged to sense the temperature in the vicinity of the catalyst, and means for controlling the operation of the heating element during self-cleaning in dependence on the temperature of the sensor.

2. A pyrolytic oven as claimed in Claim 1, in which the control means is arranged to switch the heating elements off in response to the sensing of an exothermic reaction at the catalyst.

3. A pyrolytic oven as claimed in Claim 2, in which the control means is arranged to switch the heating elements on and off to maintain the temperature of the sensor within the range from 450°C to 600°C.

4. A pyrolytic oven as claimed in any one of Claims 1 to 3, in which the control means is arranged to switch off the heating element when the temperature sensed by a temperature sensor in the oven exceeds a predetermined temperature.

5. A pyrolytic self-cleaning oven as claimed in any one of Claims I to 3, in which the control means is arranged to switch the heating element off when the temperature difference between the temperature sensor of the oxidation catalyst and a temperature sensor in the oven falls below a predetermined value.

6. A pyrolytic self-cleaning oven as claimed in any one of Claims 1 to 5, including an inlet vent for allowing preheated air into the oven at a position close to the oven outlet.

7. A pyrolytic self-cleaning oven as claimed in any one of Claims 1 to 6, in which the oxidation catalyst is on a porous plug in the outlet from the oven.

8. A pyrolytic self-cleaning oven as claimed in Claim 7, in which the porous plug is located adjacent to the heating element.

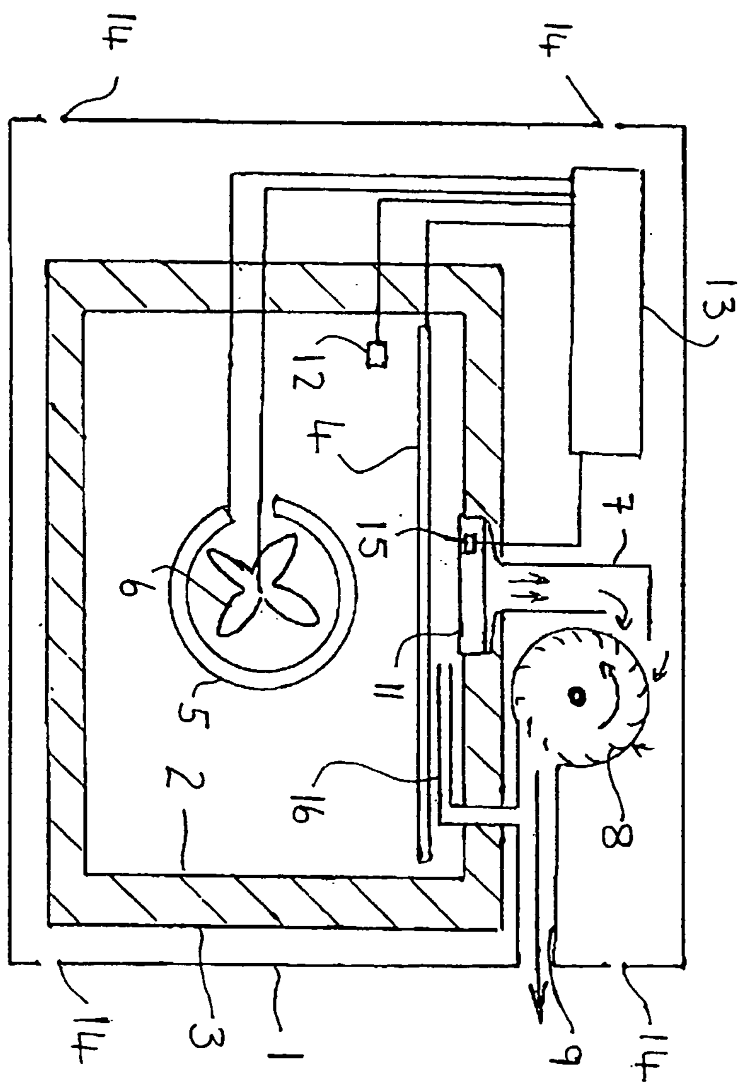

FIGURE 1

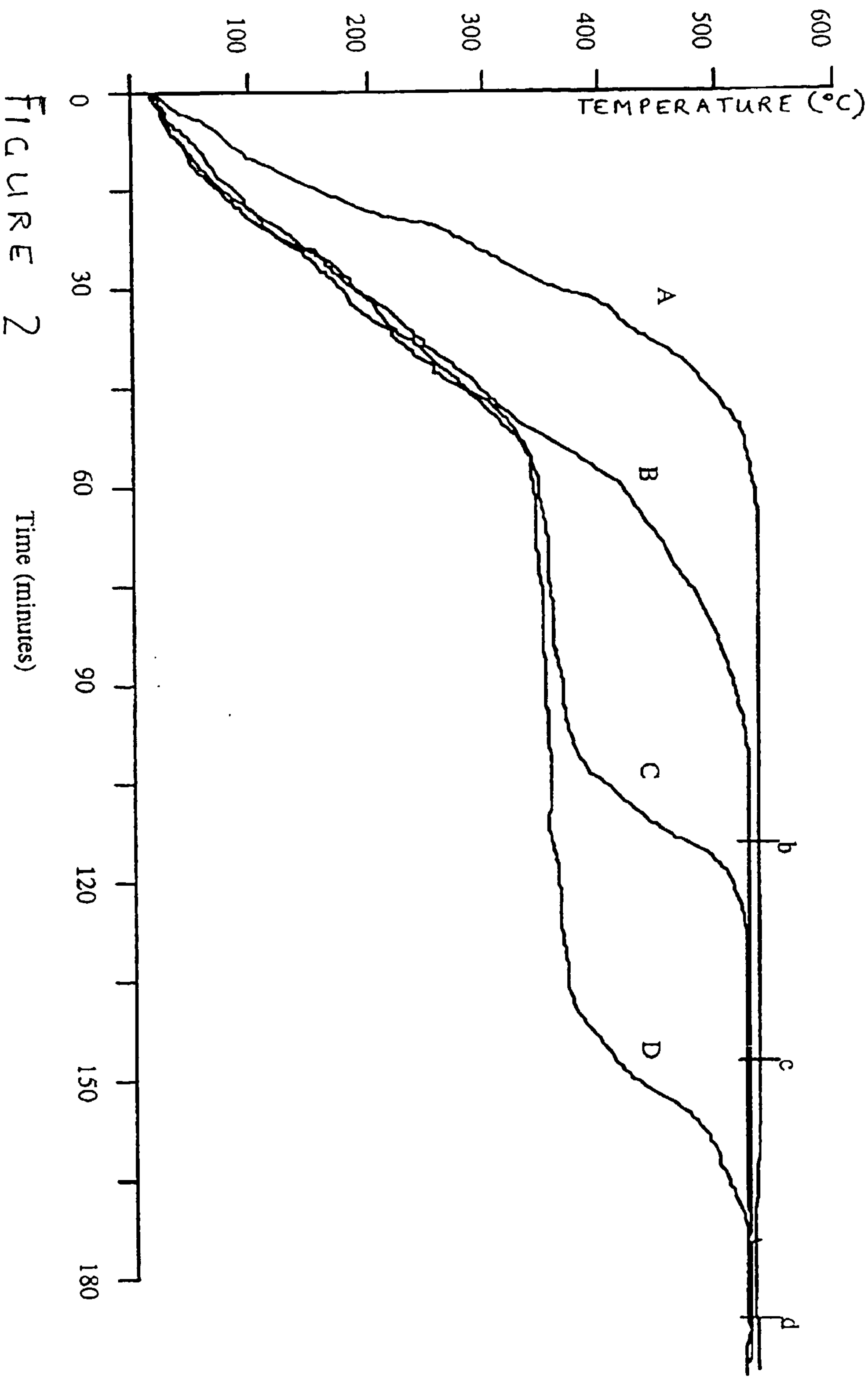
TEMPERATURE (°C)
100
200
300
400
500
600
Time (minutes)
0
30
60
90
120
150
180
A
B
C
D
b
c
d

FIGURE 2